

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554**

In the Matter of

Spectrum Policy Task Force Seeks
Public Comment on Issues Related to
Commissions Spectrum Policies

ET Docket No. 02-135

COMMENTS OF MOTOROLA, INC.

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Table of Contents

Summary	ii
I. Spectrum Mangement Principles	2
II. Need for comprehensive spectrum policy.....	4
III. Market-Oriented Allocation and Assignment Policies	8
A. Commercial Licensed Spectrum	11
B. Unlicensed Consumer Spectrum.....	13
C. Experimentation, Innovation, and New Technologies.....	16
IV. Interference Protection.....	17
V. Spectral Efficiency.....	19
VI. Public Safety	21
VII. International Issues	25
VIII. Conclusion	27

Summary

Motorola commends the Commission's Spectrum Task Force for initiating this process for review of the current spectrum policies. Radio communications play an increasingly important role in how people live, businesses operate and the safety and security of our country is preserved. As the scope and scale of systems and services available to meet the communications needs of users continues to increase, proper management of the spectrum resource becomes increasingly important. Real world spectrum management is a blend of technical, economic, and public interest objectives in a way that provides the greatest benefit to the public. It is important to recognize that there is no single blanket approach to managing the spectrum. It is necessary for the FCC to apply a variety of different approaches and rules that best meet the needs of users. While the specific rules and service structure may vary, it is possible to apply guiding principles to ensure a consistent and thoughtful approach.

Proper spectrum management will provide a structure that accommodates services meeting the requirements of users, provide the regulatory certainty necessary to drive investment in deployment of services and systems but with sufficient flexibility to allow an evolution of technologies, promote efficient operations, and provide opportunities for the introduction of new technologies. It is indeed a daunting task to balance these numerous, and sometimes competing, requirements, but finding the proper balance is key to promoting a competitive industry that leads in technology and provides the means for a more efficient and safer society.

Motorola is committed to working with the Commission to ensure that U.S. spectrum policy best meets the needs to serve and protect the American public.

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Motorola, Inc. (“Motorola”) is pleased to submit these comments in the above captioned proceeding in response to the Commission’s recent *Public Notice* (“PN”).¹ As a technology company with \$4.3 billion dollars dedicated to research last year² and an equipment supplier and technical advisor to public safety, private wireless and commercial licensees, we offer our views on creating a Commission policy that best serves the public interest, meets the needs of all wireless users and provides for the evolution of technologies and introduction of new technologies.

Radio communications play an increasingly important role in how people live, businesses operate and the safety and security of our country is preserved. As the scope

¹ Spectrum Policy Task Force Seeks Public Comment on Issues Related to Commission’s Spectrum Policies, ET Docket No. 02-135, Public Notice, FCC DA 02-1311 (released June 6, 2002) (“PN”).

² 2001 Summary Annual Report, http://media.corporate-ir.net/media_files/NYS/MOT/reports/032902ar.pdf

and scale of systems and services available to meet the communications needs of users continues to increase, proper management of the spectrum resource becomes increasingly important. Real world spectrum management is a blend of technical, economic, and public interest objectives in a way that provides the greatest benefit to the public. It is important to recognize that there is no single blanket approach to managing the spectrum. It is necessary for the FCC to apply a variety of different approaches and rules that best meet the needs of users. While the specific rules and service structure may vary, it is possible to apply guiding principles to ensure a consistent and thoughtful approach.

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I. SPECTRUM MANGEMENT PRINCIPLES

In creating an effective plan for managing the spectrum, a set of guiding principles must be adopted against which individual decisions can be made. Motorola provides the following such principles:

- 1) ***Based on user requirements*** – Regulators must understand the needs of the users for which the spectrum is being allocated. Not all users or types of spectrum use are alike. To be effective, spectrum management must match the users' needs, including consideration of cost effective communications.

- 2) ***Provide users with regulatory certainty*** – Allocation decisions should be made consistent with an overall framework for use of the spectrum that provides users with certainty that they will have full access to the spectrum and will be able to operate without suffering harmful interference from co-channel or adjacent channel licensees.
- 3) ***Promote efficient operation*** – Promoting efficient use of the spectrum is increasingly important. Efficient operation and spectrum use is much broader than merely a measurement of bits/Hz. The least efficient spectrum use is that which does not meet the users' key communications requirements. One of the best ways to facilitate efficient use of the spectrum from a regulatory perspective is to provide a clear framework for how the spectrum will be used. Greater certainty about how the spectrum will be used will make the spectrum more attractive to manufacturers and licensees and will drive greater investment and competition in technologies. Equipment must be designed to be cost effective and usable in the environment that it must operate. An uncertain environment where interference protection or the interference environment is highly uncertain makes it very difficult to design for efficient spectrum use and will drive away investment.
- 4) ***Harmonization*** – Manufacturing and services are increasingly done on a global scale and global harmonization should be a goal for any allocation decision. Harmonization will drive investment in technologies and services and will result in lower costs due to economy of scale. While differences in uses and requirements sometimes make harmonization difficult, it should always be the goal and should be the norm rather than the exception. The U.S. should take a leadership role shaping the international harmonization of spectrum use to ensure that it meets U.S. objectives and that U.S. bands can be deployed in other countries to the extent possible.
- 5) ***Make technical sense*** – Allocations should be made in accordance with a technical framework that meets services and users requirements. For instance, wide-area mobile operations are best accommodated below 3 GHz while most fixed services and some localized on-site operations can be accommodated in higher frequencies. It is also more efficient to provide larger blocks of frequencies for a service rather than spread allocations over numerous smaller bands. As services have been allocated over the years, and not according to any overall plan or vision, we've ended up with a patchwork of relatively small pieces of spectrum that quickly fill up and can result in incompatible services being in adjacent bands. Taking a longer view on spectrum use would help ensure that sufficient spectrum would be allocated to cover both near term and long term needs and would help ensure compatible operations.
- 6) ***Flexibility*** – There should be sufficient flexibility to allow evolution of technology and services. However, flexibility must be properly balanced against the higher level need to protect users from interference and provide sufficient definition to attract investment.

II. NEED FOR COMPREHENSIVE SPECTRUM POLICY

One of the biggest impediments to effective spectrum management in the U.S. is the lack of a comprehensive and long-term spectrum policy. The U.S., unlike almost any other country, divides the management of spectrum between two agencies. The Federal Communications Commission (FCC), an independent regulatory agency, is charged by the Communications Act of 1934 with managing all non-federal government spectrum, including commercial, state and local government uses. At the same time, the Communications Act preserved the President's authority to manage all spectrum used by the federal government. The President delegates this authority to the Assistant Secretary of Commerce for Communications and Information who is also Administrator of the National Telecommunication and Information Administration (NTIA).³ This bifurcated management structure ensures a lack of a single clear leader in U.S. spectrum management, resulting in the absence of a comprehensive national spectrum policy, the absence of a long-term spectrum plan, and most importantly, the absence of enough spectrum for a number of services, including the commercial wireless industry and public safety. It has resulted in what spectrum is available for commercial use costing exorbitant amounts at auction and being out of alignment with predominant spectrum usage in other parts of the world and threatens to continue this trend in defining spectrum for next generation services. This, in turn, has created uncertainty, confusion and stagnation in the commercial wireless sector.

³ The Communications and Information Policy function within the Department of State also has a role in U.S. spectrum management in terms of coordinating development of U.S. positions for and leading U.S. delegations at international conferences dealing with spectrum issues.

Separate treatment of Federal Government and civilian allocations predates the Communications Act of 1934, and recognition of the problems this creates is not new. In 1933, under President Roosevelt's direction to study the issue of the regulation of communications, a congressional subcommittee identified the crucial problem as "no single Government agency charged with broad authority".⁴ While the resulting Communications Act of 1934 created the Commission and provided for unified control of all civilian communications facilities in a single body, the 1934 Act did not address the heart of the matter. The conclusion found in the 1951 report of the President's Communications Policy Board, a board established by President Truman's Executive Order 10110, dated February 17, 1950, to study the present and potential use of the frequency space by both the Federal Government and the civilian users and to make recommendations on the most effective use of radio frequencies⁵:

"The whole Government telecommunications structure is an uncoordinated one and will be even less adequate in the future than it has been in the past to meet the ever growing complexities of telecommunications. A new agency is needed to give coherence to the structure."⁶

Recently the Defense Science Board task force in its report on DoD frequency spectrum issues has arrived at similar conclusions.⁷ The mission of the Board is to advise, in response to taskings, the Secretary of Defense, the Deputy Secretary of Defense, the Under Secretary of Defense for Acquisition, Technology and Logistics, and

⁴ S. Doc. 144, 73d Cong., 2d Sess. (1934).

⁵ 15 FR 909.

⁶ Quoted in Hearing, Subcommittee of the Committee on Interstate and Foreign Commerce of the House of Representatives, 86th Cong., 1st Sess., June 8, 9, 1959, p. 23 at 134.

⁷ Report of the Defense Science Board Task Force on DoD Frequency Spectrum Issues, "*Coping with Change: Managing RF Spectrum to Meet DoD Needs*", November 2000.

the Chairman of the Joint Chiefs of Staff on matters relating to science, technology, research, engineering, manufacturing, acquisition process, and other matters that are of special interest to the Department of Defense. In its report the board concluded:

“The United States lacks a national spectrum policy / strategy. The multiplicity of organizations charged, by the Communications Act of 1934, with spectrum management responsibility in the US each have different goals, objectives and constituencies. There is no effective mechanism to resolve conflicts, such as those that arise from pressures for spectrum from burgeoning civilian wireless services and military necessity. US delegations’ ability to negotiate at international spectrum allocation meetings is hampered by lack of consistent attention to international spectrum matters. DoD must push for a single, national authority to rationalize the nation’s approach to allocation the limited spectrum resource.”

Despite this historic recognition that a bifurcated approach to spectrum management is unworkable, it continues today. While it is beyond the authority of the Commission to formally address the structural divide in U.S. spectrum management, it is imperative that any spectrum reform effort be taken in conjunction with the NTIA. Absent such a joint effort, it will not be possible to provide meaningful change in U.S. spectrum management.

While both the Commission and the NTIA recognize the need to reform spectrum management policies, rather than initiate a joint effort to provide a comprehensive spectrum management vision for the country, both have undertaken separate initiatives.⁸ Continuing down the road of separate and distinct spectrum management principles and policies for Federal and civilian spectrum will limit the usefulness of reform efforts and

⁸ Commissioners and Commission staff did participate to a significant extent in an NTIA *Spectrum Management and Policy Summit* held on April 4 and 5, 2002, but it was not a joint summit. No NTIA personnel have been appointed to participate in the FCC Spectrum Task Force.

sets the stage for continued lack of a cohesive process for planning and implementing meaningful change in spectrum policies for all services.

The lack of a comprehensive spectrum policy has severe consequences both for U.S. domestic productivity as well as U.S. global competitiveness. Without additional spectrum to put more communications and Information Technology (IT) applications into the hands of more end-users, the U.S. cannot maintain and advance its position as a leader and shaper of the 21st century global economy and society. Not only does this have consequences for job creation by the wireless industry, which could be substantial, it puts at risk many existing jobs in the wireless sector.

Similarly, as recognized by the Defense Science Board task force, the current system does not service the best interests of our military. The U.S. should have a spectrum policy that supports Homeland Security by ensuring adequate spectrum for local and state public safety, Federal Law enforcement and related Defense activities. Failure to fully protect this nation's residents and businesses also can have a drastic impact on the economy.

Accordingly, the Commission and the NTIA should combine their spectrum management reform efforts and develop solutions that best serve the public by providing a comprehensive spectrum management plan meeting the needs of both the federal and civilian users. A combined approach is especially important at a time when spectrum management issues, such as ultra wideband and attempts to find spectrum for third generation mobile services, increasingly bridge jurisdictional authority.

III. MARKET-ORIENTED ALLOCATION AND ASSIGNMENT POLICIES

The Commission should balance a flexible market-oriented approach with a need to provide market certainty in order to drive investment and deployment of services and to ensure that spectrum is available for the provision of certain services, such as public safety and critical infrastructure. Spectrum for public safety services is addressed in Section VI of these comments. In contrast, this section focuses on commercial licensed services and unlicensed consumer applications. Flexibility is a word that has many meanings to many people, both in the Commission, on Capitol Hill and in the private sector. Flexibility must be applied in a way that allows services to evolve and new technologies to be introduced in order to meet the needs of users and allow licensees to take advantage of spectrum efficient technologies, but not in a way that creates uncertainty regarding the interference or operating environment.

As described in the Public Notice, the Commission has variously used granting existing licensees additional flexibility and overlay licensees as means to provide service flexibility and move toward a market-oriented approach. However, the Commission has also taken more aggressive action and in some instances has reallocated spectrum from one service to another, issuing new licensees and making provisions to transition the incumbents out of the band. Any of these approaches may be valid ones to make spectrum available for services that meet the needs of users and the appropriate course of action will depend on the specific circumstances (i.e., what is the existing service, what is the new service and what is the current status with regard to use of the band). Again, there is no “one size fits all” approach to managing spectrum.

In determining the appropriate approach the Commission and NTIA should work together to have a long-term understanding of industry trends and user requirements, and use this understanding to create a long-term road map, into which individual decisions can be made. While it is not possible to predict the future with any degree of accuracy, it is possible to have an idea of general requirements for a broad range of services and to plan for long-term spectrum shifts accordingly. Within these broad service ranges, flexibility should be provided to allow licensees to adapt services and technology to best meet the needs of their users.

The Commission should not rush to auction spectrum just for the sake of putting spectrum on the market as quickly as possible. While the theory is often espoused that moving to auction spectrum as quickly as possible will result in it being put to its best and highest use and make services available as quickly as possible, history has not shown this to be the case. For example, while the Commission auctioned off spectrum for the Wireless Communications Service over five years ago, in April 1997, there has been little actual use of the spectrum and licensees have struggled with an uncertain technical and regulatory environment. A much more positive example of spectrum management is the Personal Communication Service. With PCS, a service requirement was identified, a technical framework and mechanism to transition the spectrum from incumbent users was developed prior to licensing the spectrum. As a result of the certainty created by a well thought out regulatory structure, PCS services were deployed very quickly following licensing and a strong competitive industry has developed. The PCS rules also provide the flexibility for licenses to evolve their service using the latest technologies and in response to user demands, or even to use their spectrum for different services in different

areas (such as fixed rather than mobile services) provided the operation fits within the compatible technical framework.

The Commission and NTIA should work together to create regulatory certainty regarding the interference environment. In developing a technical framework, the Commission should avoid creating the uncertainty caused by rules that allow services with very different technical characteristics to operate co-channel or adjacent channel. For example, the Commission should:

- Avoid mixing TDD and FDD technologies within the same bands. In order for compatible operation between these technologies, severe restrictions on devices and deployments are required.⁹
- Segregate high power and low power architecture systems including avoiding mixing interference limited systems with noise limited systems. Many examples of where problems exist can be found by examining the current issues surrounding interference into public safety.
- Segregate very different services, such as satellite and terrestrial services where compatibility is problematic unless clear sharing rules are developed beforehand.

In developing a long-term vision, the Commission and the NTIA should work closely with industry and should take into consideration estimates of future spectrum requirements such as those prepared by PSWAC for public safety and the ITU for third

⁹ Motorola comments, ET Docket No. 00-255, October 22, 2001, at p. 15-18

generation mobile services and unlicensed operations.¹⁰ Such planning work will help the Commission to plan an appropriate balance of spectrum for categories of services, which should continue to include licensed and unlicensed spectrum. Each type of licensing structure meets demands and service requirements to address unique service capabilities that cannot be delivered by a sole licensing mechanism.

A. Commercial Licensed Spectrum

Since path loss associated with non-line-of-sight terrestrial propagation generally increases as the frequency increases due to enhanced scattering and diminished diffraction there are technical and economic advantages to locating systems intended to cover wide areas in spectrum at lower frequencies where coverage is more readily achieved. Existing area coverage systems having modest channel bandwidths typically employ spectrum below 3 GHz. The wide-area commercial mobile systems in this frequency range are characterized by the existence of a service provider, licensing, and rules to help ensure service quality and coverage.

Within the wireless telecommunications industry, one of the next growth opportunities will be the deployment of ubiquitous broadband mobile wireless data services, e.g. third generation (3G) services. Current, wide-area mobile communications systems are largely low bit rate and voice-centric. Given the trend toward broadband in

¹⁰ See Final Report of the Public Safety Wireless Advisory Committee to the Federal Communications Commission and the National Telecommunications and Information Administration, September 11, 1996, (“PSWAC Final Report”), SRSC Appendix C, “Public Safety Wireless Advisory Committee Model for Prediction of Spectrum Need Through The Year 2010 - A White Paper, 9. Geographic Reuse (REUS). See ITU-R Report M.2023, Spectrum requirements for International Mobile Telecommunications-2000 (IMT-2000). See ITU-R, “5 GHz Spectrum Requirements [Res. 736, resolves 1] for Wireless Access Systems including RLANs”, Attachment 15 to chairman’s report of the fourth meeting of JRG 8A-9B, 8A-9B/132, 8 May 2002.

wired communication today, a shift to higher bit rate wireless applications is inevitable. Third generation systems and WLANs providing hot-spot coverage are presently emerging to fill this market space; however, the small coverage area provided by a WLAN makes ubiquitous coverage difficult to achieve and only cost effective in densely populated areas. So while small coverage area systems may be a component of the entire network, spectrum must be available to provide ubiquitous service. Since no other available wireless technology is suitable for this kind of service, the required technologies must be cultivated and the FCC has a huge role to play in this development. A key initial step forward is the allocation of spectrum for 3G services.

Looking forward, the FCC's spectral policy should try to align band assignments to maximize the overall utilization of the spectrum. As part of this realignment, the amount of spectrum available to wide-area mobile and portable services should be increased to accommodate services beyond 3G mobile applications. The identification of spectrum is critical to the success of future broadband mobile business and the Commission should work with industry to identify viable candidate bands that fit within a long-term plan. For instance Motorola has had extensive experience in fielding a beyond 3G experimental broadband wireless system at 3.7 GHz.¹¹ The increase in path loss with increasing frequency makes spectrum above 6 GHz economically unattractive for beyond 3G mobile systems.¹²

¹¹ Batariere, M., Kepler, J., Krauss, T., Lisica, I., Porter, J., Vook, F., "Experimental Broadband Mobile OFDM System: Description and Initial Results," *11th Virginia Tech MPRG Symposium on Wireless Personal Communications 2001*, Blacksburg, VA, 6-8 June 2001

¹² For example, the mean penetration loss for a building typical of office structures is 17.7 dB at 900 MHz, 19.8 dB at 11.4 GHz, and 34.1 dB at 28.8 GHz. Allen, K. C., *et al.*, "Building Penetration Loss Measurements at 900 MHz, 11.4 GHz, and 28.8 GHz," NTIA Report 94-306, May 1994, p. 23. In addition,

B. Unlicensed Consumer Spectrum

One area in which the Commission should be applauded is the promotion of devices that are permitted to operate without individual licenses, i.e. unlicensed spectrum. The technology using unlicensed allotments has experienced rapid innovation and growth due to the relatively few regulatory impediments to bringing equipment to this market place. In order to continue to foster rapid innovation and deployment, additional spectrum is required.

Spectrum availability is an overriding consideration for the emerging commercial wireless local area and personal area networks (WLAN and WPAN) that typically require a channel bandwidth exceeding several megahertz. Since the range of these systems is typically limited, licensing is not necessary, but rules sufficient to provide for compatible operation while still permitting the development of innovative technologies and experimentation are appropriate.

The use of unlicensed spectrum continues to grow, both in terms of the number of devices deployed and the number and types of applications. The move toward broadband wireless applications is increasing the demands on the existing unlicensed spectrum. These demands can be expected to continue to increase as WLAN and other devices proliferate. Many believe that broadband wireless in the home is a significant market that will continue to emerge in the next few years. The convergence of the computer and consumer electronics industries will lead to the appearance of devices such as Internet connected game consoles, web appliances, and new audio and video gear. A wireless

higher carrier frequencies are associated with higher Doppler frequencies, making channel estimation and tracking more difficult.

home network infrastructure is needed to interconnect consumer electronic devices and to attach to the Internet. The desirability of interconnecting consumer devices without wires is obvious. For example, broadband wireless home networks will permit the placement of standard and high definition televisions and related components anywhere in the home without the cost and inconvenience of wire installation.

In order to satisfy emerging demand for unlicensed devices, Motorola urges the Commission to quickly issue an NPRM in response to Wireless Ethernet Compatibility Association's Petition for additional unlicensed spectrum at 5 GHz (5.470-5.725 GHz).¹³ For longer-term development of consumer unlicensed devices the Commission should consider new spectrum allocations above 10 GHz where the greater propagation loss is compatible with the limited coverage area of a typical WLAN. Finally to complete the future spectrum landscape the Commission should, to the greatest extent possible, allocate fixed access systems to frequencies above 6-10 GHz.

Spectrum management experts debating the concept of unlicensed spectrum have raised concerns with "tragedy of the commons" aspects of unlicensed allocations in which, as congestion rises, spectrum may not be put to its highest valued use. The Commission has at its disposal two methods for resolution of this issue; the first is ensuring that adequate spectrum is available to meet demand. The second is the establishment of rules for accessing unlicensed frequencies. Since much of the success in

¹³ The study of the bands 5.15-5.35 GHz and 5.470-5.725 GHz is on the agenda for the next World Radio Conference (Agenda Item 1.5) (WRC-03) where allocations for will be considered to meet demand for wireless access systems. The Commission should act quickly in this proceeding in order to fully develop its record on which to base not only its decision on the pending WECA application, but also the US position at WRC-03.

the unlicensed band relies on minimal rules, the Commission must carefully consider how additional rules will limit innovation. For those cases where additional constraints are required to ensure compatible operation, the Commission should develop rules that balance the need for high quality of service and efficient spectrum use in high-density congested environments with interference protection and other compatibility issues.¹⁴

As congestion rises, some uses of unlicensed spectrum will be at a distinct disadvantage under current rules. The characteristics of such disadvantaged uses include real-time applications with a low tolerance for delay, the need for very high quality of service and protection from uncontrolled interference, and high bit rate applications that are more vulnerable to interference due to the lower energy per bit. One such system with these characteristics is voice-over-IP where performance equivalent to wired communications is desired. Another example is in-home video distribution in which the consumer will immediately observe small interruptions in the data stream from uncontrolled interference. If these services are employed in existing unlicensed spectrum, such as the U-NII bands, other unlicensed devices serving uses with less demanding performance requirements will create intolerable interference to devices that are more vulnerable to uncontrolled interference as congestion rises. To ensure that these new services are viable, new rules are needed to provide for equitable access to and utilization of unlicensed spectrum without disadvantage to particular uses. Dynamic Frequency Selection (DFS) and Transmit Power Control (TPC) are two such techniques.

¹⁴ Such rules could include channel definitions, spectrum monitoring requirements, interference avoidance requirements, spectrum access criteria, power spectral density limits, power control requirements, spectrum efficiency requirements, spectrum occupancy limits, and other requirements necessary to achieve the desired performance.

These rules should be implemented in new consumer-oriented unlicensed spectrum allocations.

C. Experimentation, Innovation, and New Technologies

The Commission's spectrum policies should continue to foster experimentation, innovation and development. The current method of encouraging broadband product development for new frequency bands has some serious drawbacks in that it is difficult to find target bands to deploy new technologies. Today, there is no clear path to get from product/service concept to the broadband mobile market place. For any organization wishing to explore this market, there are several factors working against their potential development. Importantly, there are no identified blocks of spectrum large enough upon which to build a profitable business, even if the technology was fully developed. And it is uncertain what spectrum, if any, will become available. When spectrum is made available, it is either too little to stand on its own, is fraught with legacy baggage, has too short of a time schedule or is in too high of a frequency band to be of significant market interest/value. All of these things combine to create a high-risk economic picture that discourages the R&D needed for the development of new technologies.

New technologies, breakthroughs and innovation will come from the wireless telecom industry, but funding is an issue. The technological advancements required to ensure continued growth of the wireless telecom industry include: low-cost microwave and millimeter-wave IC processes and RF components¹⁵, linear, efficient power amplifier technology, adaptive modulation/coding and antenna array techniques, and novel system-

¹⁵ Digital process improvements come from the computer industry.

level deployment concepts. Advancements in these core technologies require a significant human and capital investment that is only justified if there is some certainty that spectrum will be available to for implementation.

A closer relationship between the Government and industry on research would be mutually advantageous and would help defray the costs to both. In a highly competitive manufacturing industry, it becomes increasingly difficult to dedicate the significant resources necessary to develop new, efficient technologies. The Commission should look for opportunities to partner with industry to better understand the radio environment and to help form industry/government partnerships that advance the radio science.

IV. INTERFERENCE PROTECTION

Interference protection is at the heart of many contentious debates before the FCC when considering spectrum use. Existing users of spectrum desire protection from new entrants, while new entrants desire the maximum amount of flexibility in bands they intended to deploy new services. In most all situations some level of interference in the shared or adjacent spectrum will always be present but the impact of interference should be minimized and the rights of incumbent operators clearly defined.

Motorola believes there are several key issues that the Commission and NTIA should recognize in addressing interference.

- 1) The level of interference that can be tolerated may vary depending on the depending on the nature of the service involved.
- 2) The technical factors contributing to interference cannot be viewed in isolation of the system and user requirements. Systems structured to best met

user requirements may differ significantly. For example, deployment requirements of commercial systems and public safety systems differ significantly and mixing them in the same spectrum can increase interference, as evidenced by the Commission's rulemaking on 800 MHz rebanding.

- 3) All systems require some degree of margin to ensure reliable communications.

This margin is intentionally a part of the system design because reliability is subject to the vagaries of propagation and other environmental variations.

Commission analysis should not assume that eliminating that margin is acceptable.

- 4) The Commission should fully understand the economic and service impact on

incumbent services when considering permitting a potential source of interference to operate. Incumbent systems may require significant redesign or investment when faced with increased interference, and the Commission must carefully weigh that when authorizing a new service.

- 5) The Commission should base analysis on appropriate and accurate

propagation models and should update outdated models. For example, in some cases R6602 are still used exist for predicting coverage and interference of mobile communications systems.

- 6) When Commission rules require changes to equipment designs, or for a

transition of services, dates certain may be needed but must also consider the existing investment and need for a smooth migration that users can afford.

In short, spectrum management should fully consider engineering as well as economic and legal issues to create a stable environment that meets the needs of users, creates an environment friendly to reliable communications, while still allowing deployment of new technologies.

V. SPECTRAL EFFICIENCY

The Commission should not define and impose specific spectrum efficiency standards. Appropriate standards would vary by service and geographic area depending on the service requirements and the demand for spectrum, and would continuously change as technology advances. It is not possible or reasonable for the Commission to try to keep pace with such a changing and diverse range of standards. The correct course is to provide the incentives and the opportunity for efficient spectrum use and let the market and users decide reasonable tradeoffs between the economic viability of a technology and using the spectrum as efficiently as possible. There is often an economic tradeoff associated with achieving high spectral efficiency that must be considered for commercial systems. Implementing market-based incentives for efficient spectrum use is one of the best approaches to provide the balance between spectrum efficiency and the need for a cost effective service.

Rather than try to define specific spectrum efficiency requirements, the Commission should look for opportunities to allow efficient use and encourage development and implementation of new technologies. One promising, but long-term

approach is *Cognitive Radio*, a term defined by J. Mitola^{16, 17} of MITRE Corporation to describe a radio and associated radio system that is highly adaptive to user needs and the current physical environment and that has the capability to learn and adapt automatically. The purpose of the adaptation is to make the most efficient use of spectral resources while servicing a wide range of user applications. The ability of the radio system to learn and adapt automatically is considered essential due to the complexity of the total adaptation problem. The term *cognitive radio* has recently been applied to radio systems that do not learn but that do have a high degree of flexibility to adapt at least to the radio communications physical environment. We agree with the assessment of J. Mitola that learning will be required to achieve the long-term goal of obtaining the highest public value from the radio spectrum. However, we believe that this long-term goal can be achieved via smaller optimization steps that may not, at first, require a learning ability in the radio system or user equipment.

Intelligent radio systems and subsequently cognitive radio systems will be important for enhancing the public benefit of spectral resources. It may take a decade or more before these radios are available with acceptable size, cost, and battery drain and they may never be competitive for services where the equipment cost to the end user is a significant issue. Enabling technologies for these systems include the development of an intelligent radio resource manager along with the associated spectrum monitoring and usage prediction processes and the development of cost effective software defined radios

¹⁶ Joseph Mitola III, "Cognitive Radio: Making Software Radios More Personal", *IEEE Personal Communications*, Vol 6, No 4, August 1999.

¹⁷ Joseph Mitola III, "Cognitive Radio: An Integrated Agent Architecture for Software Defined Radio", Dissertation for the degree of Doctor of Technology, Royal Institute of Technology, Kista, Sweden, May 8, 2000.

implementable in small hand held user equipment. The radio resource manager must have fail-safe provisions for meeting priority needs at all times and places. The Commission should identify frequency bands that where a first iteration of an intelligent radio system can be implemented that will eliminate the potential for interference to critical services. As the technology matures implementation can be expanded. The spectrum policy issues created by the concept of radio resource management spanning current cellular, commercial dispatch, possibly public safety, and possibly government and military bands are considerable. These issues include, but are not limited to, the need to clearly define the rights of incumbents, a process for developing and managing the radio resource manager and mechanism for encouraging deployment of such a service while balancing the need for more traditional technologies.

VI. PUBLIC SAFETY

Public safety and public service agencies at the federal, state and local levels, as well as critical infrastructure industries, require highly reliable radio-based communications services. Like other users of the radio spectrum, the spectrum needs of these specialized users are increasing. The Commission seeks comments on how to best preserve and protect the ability of public safety, public service and critical infrastructure entities to do their important jobs in light of the increasing spectrum demands for these and all other services.

The public safety community has long identified its growing need for spectrum. The Public Safety Wireless Advisory Committee (PSWAC) issued the latest and most recognized spectrum requirements report on September 11, 1996. In 1993, Congress required the FCC to complete a study of current and future spectrum needs of the US

public safety community through the year 2010, and develop a specific plan to ensure that adequate frequencies are made available to public safety licensees. The FCC, together with the NTIA, chartered PSWAC in June 1995 to provide advice on the specific wireless communications requirements of public safety agencies through the year 2010 and make recommendations for meeting those needs. The membership of PSWAC totaled over 480 participants representing a broad range of state, local and federal public safety agency officials, public and commercial service providers, and manufacturers. The PSWAC Steering Committee included senior officials from the FBI, Department of Defense, Department of the Treasury, New York City, Los Angeles County, IACP, APCO, Ericsson, and Motorola.

PSWAC issued its report to the FCC almost six years ago which concluded that the public safety community requires 97.5 MHz of additional spectrum allocations to meet its mission critical wireless communications needs: 2.5 MHz is needed immediately for interoperability, 25 MHz is needed in the short term (by end of 2001), and an additional 70 MHz is needed by 2010. This need is driven in the short term by voice and rapidly growing data communications. However, the greatest need for additional spectrum over the next ten years will be for advanced wideband and broadband technologies.

To date, the Commission has allocated 24 MHz to public safety in the 700 MHz band, split evenly between narrowband voice/low speed data and wideband data and 50 MHz in the 4.9 GHz band for broadband applications. Though allocated, there is no certainty as to when the 700 MHz this spectrum will be fully available because there is no date certain as to when the incumbent broadcasters will vacate the band. The

Commission has a proceeding in progress to develop the technical rules and licensing requirements for the 4.9 GHz spectrum.

While we commend the Commission for the above allocations to help toward public safety's documented spectrum requirements, we urge the Commission to make this spectrum accessible to the public safety community by clearing all incumbents from the 700 bands and finalizing the 4.9 GHz technical rules. Further, we urge the Commission to allocate additional public safety spectrum to complete the response to PSWAC's documented spectrum requirements.

Motorola also supports the conclusion of PSWAC¹⁸ that 1) minimum baseline standards are required for unit-to-unit public safety radio equipment operating in the same band, and 2) the development, provision, and utilization of interfaces/gateways between and among independent public safety and public service infrastructures and between public safety and commercial infrastructures should be encouraged. One such way to achieve is via standards developed by a fair and open process that encourages industry to cooperate in order to provide the tools and technology needed by the public safety community.

An example of this standard is APCO Project 25 (called Project 25), a key element to ensure the availability of dependable, interoperable and cost-efficient radio-based and other communications services among local and state public safety and federal government agencies in their use of spectrum for public safety, law enforcement, homeland security, and critical infrastructure protection. The Project 25 standards are

¹⁸ See *PSWAC Final Report* at 19.

developed under the guidance of the Telecommunications Industry Association (TIA) whose standard formulating committees include manufacturer representatives. TIA standards are developed using open procedures that are required by the American National Standards Institute (ANSI). These are the five objectives of the Project 25 standard:

- Spectral efficiency using narrow band channels
- Interoperability between agencies and different levels of government
- Backward compatibility
- Graceful system migration (forward and backward)
- Scalable Trunked and Conventional capabilities

Consistent with our earlier support of finding innovative approaches to spectrum management we support the Commission evaluating novel sharing mechanisms to address spectrum congestion. As the Commission points out, the key aspect is that public safety services must continue to meet the special needs for a highly reliable system in order to deliver communications to its users. In this respect, regulatory assurance must be present so that when an emergency situation occurs the spectrum requirements for public safety and related functions demand is met which means that other services may have to accept loss of access.

The amount of spectrum dedicated for the support of public safety and related functions should be determined based on recommendations by the community closest to the needs of that service, in this case the community has reported via the PSWAC report, Motorola supports that the conclusions of PSWAC on this matter are still valid today. PSWAC is chartered in accordance with the requirements of the Federal Advisory

Committee Act. The advisory committed is to advise the NTIA and FCC on the total spectrum requirements for the operational needs of the federal, state and local public safety entities, including frequency band options, shared/joint spectrum use options, and other options.¹⁹

VII. INTERNATIONAL ISSUES

Motorola recommends that the policies for spectrum use take into account international spectrum activities and use and encourages the Commission, along with the NTIA and Department of State to be proactive in promoting U.S. interests internationally. Spectrum decisions made in the U.S. that ignore the corresponding global decisions will lead to reduced opportunities for U.S. companies and increase the spectrum conflict with U.S. military operations. An example of where this conflict currently arises is the 1710-1880 MHz band where the U.S. military uses this band for its communications and GSM technology is currently deployed on a international basis. As more demand is place on this spectrum from both the international community and the U.S. military, the U.S. will find it increasingly difficult to perform joint maneuvers with its international counterparts, effectively reducing the training ability for US armed forces. Strong U.S. leadership will advance the interests of U.S. industry and the U.S. government, including DoD.

International aspects of spectrum policy should address global harmonization with the global coordination of spectrum as a priority. Harmonization is a key factor to ensure that businesses and consumers receive the benefits of economies of scale from the

¹⁹ *Id.* at 8-9

manufacturing to the global market. Harmonization will maximize interoperability among carriers and seamless roaming across national borders. The Commission can make an immediate impact by action on additional frequency allocations for third generation spectrum via band plans currently under discussion in working part 8F, WRC-03 agenda item 1.3 that considers identification of globally/regionally harmonized bands for the implementation of future advanced solutions to meet the needs of public protection agencies, including those dealing with emergency situations and disaster relief, and WRC-03 agenda item 1.5 that deals with 5 GHz spectrum allocations for RLANs. Clearly a combined FCC/NTIA spectrum policy that considers the legitimate needs of both commercial and military users should be developed so this process can move forward.

VIII. CONCLUSION

Motorola welcomes the Commission's efforts to address issues surrounding spectrum management in today's fast changing telecommunications world. Motorola looks forward to providing additional input to this reform effort and to further develop proposals in the coming months.

Respectfully submitted,

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